Ministry of
Transportation and
Communications

Ontario

MI-64

A REVIEW OF THE MTC CONCRETE COMPRESSIVE STRENGTH DATA FOR 1983

MATERIALS INFORMATION
ENGINEERING MATERIALS OFFICE

A REVIEW OF THE MTC CONCRETE COMPRESSIVE STRENGTH DATA FOR 1983

by

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May, 1984

INTRODUCTION

This report is a summary and discussion of the 28-day compressive strength test data from the 1983 contracts involving concrete work. The data is compared with similar data from 1981 contracts abstracted from a report prepared by G. P. Wilson entitled "Review of the MTC Concrete Compressive Strength Data for 1981".

The MTC Form 1350, Material Specification for Concrete (Materials and Production), describes a compressive strength test as:

> "the average of two standard 150 mm x 300 mm cylinders cured as per CAN 3A23.2-3C." (1350.08.02)

For the purposes of this report if a strength test result is equal to or greater than the specified strength it is considered to be in compliance. Concrete which meets the acceptance requirements of Form 1350 normally has a minimum of 96% of test results above the specified strength.

SUMMARY OF RESULTS

A complete listing of the number of cylinder tests, the average, the standard deviation and the variance for each contract, for all classes of concrete is given in Appendix 'A'.

The following chart summarizes, by region, the total number of strength test taken and the percentage of tests which comply with the required strength for each commonly used class of concrete.

PERCENTAGE OF CYLINDER STRENGTHS ABOVE OR EQUAL TO THE MINIMUM SPECIFIED STRENGTH

REGION	20 MPa		25MPa		30MPa		35 MPa	
	# tests	% compliance	# tests	% compliance	# tests	% compliance	# tests	% compliance
Central	608	100%	35	100%	667	92%	361	97%
S.W.	115	100%	-	-	102	91%	19	100%
N.W.	36	97%	-	-	53	79%	-	-
Northern	33	100%	-	-	82	87%	-	-
Eastern	100	97%	6	83%	238	72%	3	100%
TOTAL	892	99.6%	41	97.6%	1142	86.9%	383	97.1%

DISCUSSION

(A) 20 MPa

This is the second most commonly used class of concrete. Throughout the province 892 tests were taken and 99.6% met the minimum required strength. This was the highest compliance of all the concrete classes, only Eastern and North-western Regions had failures.

The 1983 percent compliance is almost the same as the 99.5% compliance of 1981.

The high compliance of the 20 MPa concrete is most likely a result of the high minimum cement requirement of 315 kg/m^3 (Form 1350.05.01).

(B) 25 MPa Class

This class of concrete was used only in Central and Eastern Regions; of the 41 tests taken, only one test was under 25 MPa giving this class a 97.6% compliance.

Again, the high minimum required cement content is most likely responsible for the high compliance.

(C) 30 MPa Class

This is the most frequently used class of concrete with 1142 tests taken throughout the province. It also has the lowest compliance 86.9%.

Individually the Regions ranged from a 72% compliance in Eastern to a 92% in Central.

The 1983 compliance is almost the same as the 87.3% compliance achieved in 1981.

The minimum cement content specified is 355 kg/m^3 (Form 1350.05.01). With this amount of cement there should be no problem in achieving a strength of 30 MPa. The problems are probably caused by use of marginal aggregates for this class of concrete and insufficient quality control, particularly in hot weather.

(D) 35MPa

Only the three southern regions used this class of concrete. The compliance was 97.1%, this is a significant increase over 1981's 93.9% compliance. Central region was the only region in which there were problems meeting the 35 MPa requirement.

This class of concrete may have better quality control as field trial batches are required, according to Form 1350.07.04.

CONCLUSIONS

The only class of concrete which has a poor compliance percentage is the 30 MPa concrete. The new Ministry performance specification and contractor mix designs will give more responsibility for providing the Ministry with concrete of the minimum strength to the Contractor. This should help achieve a better control on the quality of the concrete, especially the 30 MPa class.

APPENDIX "A"

28-DAY COMPRESSIVE STRENGTH TEST RESULTS - SUMMARY SHEETS

Key n = Number of Tests
$\bar{x}$ = Average Strength
δ = Standard Deviation
V = Coefficient of Variation

28 DAY COMPRESSIVE STRENGTH TEST RESULTS

SUMMARY SHEET

Region: Central

Year: 1983

CONTRACT NO. C-	20 MPa				30 MPa				35 MPa				___ MPa			
	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	b	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V
1	25	30.2	2.91	9.64	13	32.3	4.47	13.84	20	41.1	3.82	9.29				
2	61	31.3	3.41	10.89	66	34.4	4.69	13.63	36	44.3	3.39	7.65				
3	19	27.8	2.80	10.07	2	31.7	1.77	5.58								
4	12	33.7	4.78	14.18	4	39.7	1.49	3.75								
5	14	34.0	2.57	7.56												
6a	57	36.3	4.16	11.46	38	38.4	4.95	12.89								
6b					19	39.0	3.52	9.02	8	44.4	3.78	8.51				
7	4	26.0	2.82	10.85	11	36.0	6.73	18.69	15	37.9	6.19	16.33				
8	18	38.3	3.16	8.25	3	41.2	1.11	2.69								
9	5	39.2	1.11	2.83												
10	3	29.7	4.07	13.70	28	33.4	4.39	13.14								
11	14	34.9	5.32	0.15												
12	6	37.4	5.09	13.61					3	38.2	0.60	1.57				
13	1	28.7	-	-	2	41.6	3.25	7.81	6	47.0	4.55	9.68				
14	4	35.7	3.91	10.95	4	36.6	3.80	10.38	5	47.0	5.60	11.91				

Key n = Number of Tests
$\bar{x}$ = Average Strength
δ = Standard Deviation
V = Coefficient of Variation

28 DAY COMPRESSIVE STRENGTH TEST RESULTS

SUMMARY SHEET

Region: Central

Year: 1983

CONTRACT NO. C-	20 MPa				30 MPa				35 MPa				___ MPa				
	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	
15	11	42.1	2.53	6.01	59	45.0	3.71	8.24					21	48.8	2.08	4.26	*
16	26	39.9	4.68	11.73	81	43.7	4.74	10.85	38	47.3	3.91	8.27					
17	31	37.5	4.08	10.88	67	40.0	4.52	11.30	101	42.3	3.51	8.30					
18	39	30.5	3.83	12.56													
19	10	27.9	4.41	15.81	7	35.8	6.89	12.25					19	32.4	4.50	13.89	**
20	4	30.7	7.92	25.80	5	30.6	5.45	17.81					4	30.7	1.97	6.42	**
21	13	31.8	3.83	12.04													
22a	4	31.5	2.77	8.79	17	29.4	7.63	25.52									
22b	4	32.5	2.31	7.16													
23	13	40.8	4.10	10.05	24	44.3	5.10	11.51	7	51.3	3.31	6.45					
24	3	29.3	2.69	9.18													
25	24	27.3	2.98	10.92													
26	4	36.2	3.06	8.45													
27a	7	35.7	6.40	17.93													
27b	5	36.1	4.25	11.77	17	42.9	3.45	8.04									

* 40 MPa
** 25 MPa

Key n = Number of Tests
$\bar{x}$ = Average Strength
δ = Standard Deviation
V = Coefficient of Variation

28 DAY COMPRESSIVE STRENGTH TEST RESULTS

SUMMARY SHEET

Region: Central

Year: 1983

CONTRACT NO. C-	20 MPa				30 MPa				35 MPa				__ MPa			
	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V
43	6	34.5	2.50	7.25	33	37.7	3.13	8.30	2	38.0	6.21	16.34				
44	28	33.4	4.79	14.34												
45	19	35.6	4.39	12.33												

Key n = Number of Tests
$\bar{x}$ = Average Strength
δ = Standard Deviation
V = Coefficient of Variation

28 DAY COMPRESSIVE STRENGTH TEST RESULTS

SUMMARY SHEET

Region: Central

Year: 1983

CONTRACT NO. C-	20 MPa				30 MPa				35 MPa				MPa				
	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	
28	4	37.6	4.25	11.30	20	40.1	4.15	10.35									
29	1	32.1	-	-													
30	20	31.0	4.35	14.03													
31	10	28.9	2.51	8.69	4	28.3	2.94	10.39									
32	2	33.2	2.33	7.02													
33	9	35.8	2.20	6.31	8	34.5	1.18	3.42									
34	2	37.5	3.75	10.00													
35									36	49.3	6.99	14.18	2	38.9	0.92	2.37	**
36					2	43.4	0.07	0.16									
37					45	37.5	3.53	9.41									
38					4	39.6	2.28	5.76									
39	15	41.1	1.55	3.77	45	44.7	3.02	6.76	75	47.5	2.17	4.57					
40	33	31.4	2.87	9.14	10	45.3	4.32	9.54	9	43.3	5.63	12.98	3	36.0	1.80	5.00	**
41	4	32.8	3.60	10.98	11	36.4	5.27	14.48									
42	14	30.6	3.95	12.91	18	32.4	5.22	16.11					7	27.3	0.85	3.11	**

** 25 MPa

Key n = Number of Tests
$\bar{x}$ = Average Strength
δ = Standard Deviation
V = Coefficient of Variation

28 DAY COMPRESSIVE STRENGTH TEST RESULTS

SUMMARY SHEET

Region: Southwestern

Year: 1983

CONTRACT NO. SW-	20 MPa				30 MPa				35 MPa				__ MPa				
	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	
1	1	31.0	-	-													
2	6	31.9	5.27	16.52													
3	10	31.1	3.50	11.25													
4	2	29.3	2.76	9.41													
5	30	32.6	5.03	15.43	20	40.9	5.29	12.93	19	40.4	3.34	8.27					
6	9	30.2	5.18	17.15													
7a					1	34.2	-	-									
7b					2	34.4	2.40	7.00									
8					2	32.6	0.64	1.96									
9	8	36.8	2.83	7.69													
10	17	35.7	3.66	10.25	4	38.8	9.14	23.55					2	46.4	0.57	1.23	*
11	2	33.9	4.88	14.40	8	37.7	4.58	12.15									
12	9	30.8	4.42	14.35	11	33.8	3.03	8.96									
13	6	32.9	3.65	11.09	10	33.8	3.11	9.20									
14	5	33.7	3.49	10.36	27	33.8	2.93	8.67									

* 35 MPa (Latex Modified)

Key n = Number of Tests
$\bar{x}$ = Average Strength
δ = Standard Deviation
V = Coefficient of Variation

28 DAY COMPRESSIVE STRENGTH TEST RESULTS

SUMMARY SHEET

Region: Southwestern

Year: 1983

CONTRACT NO. SW-	20 MPa				30 MPa				35 MPa				__ MPa				
	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	
15a	1	27.1	-	-	4	38.0	4.53	11.92									
15b					3	33.1	2.19	6.61									
16	7	39.7	2.40	6.04													
17	2	41.1	2.80	6.81													
18					10	35.1	5.23	14.90					16	43.9	3.40	7.74	*

* 35 MPa (Latex Modified)

Key n = Number of Tests
$\bar{x}$ = Average Strength
δ = Standard Deviation
V = Coefficient of Variation

28 DAY COMPRESSIVE STRENGTH TEST RESULTS

SUMMARY SHEET

Region: Northwestern

Year: 1983

CONTRACT NO. NW-	20 MPa				30 MPa				35 MPa				__ MPa			
	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V
1	14	31.1	2.71	8.71	5	37.3	1.53	4.10								
2					2	36.8	-	-								
3					8	41.8	3.21	7.68								
4	8	29.2	0.75	2.56	7	35.6	4.77	13.40					1	43.1	Tremie	
5	7	32.9	2.90	8.81	9	31.5	3.27	10.38								
6					17	32.6	2.42	7.42								
7	7	22.6	3.20	8.90	5	29.6	2.83	6.40								

Key n = Number of Tests
$\bar{x}$ = Average Strength
δ = Standard Deviation
V = Coefficient of Variation

28 DAY COMPRESSIVE STRENGTH TEST RESULTS

SUMMARY SHEET

Region: Northern

Year: 1983

CONTRACT NO. N-	20 MPa				30 MPa				35 MPa				__ MPa			
	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V
1	5	28.5	3.37	11.84	3	33.1	1.19	3.60								
2					19	32.3	1.80	5.59								
3	2	25.1	0.50	1.97	7	29.8	5.22	17.53								
4					8	34.1	1.10	3.22								
5	5	33.2	5.07	15.30	17	37.3	3.52	9.44								
6					20	32.9	1.86	5.67								
7	4	30.4	2.56	8.44	8	31.9	3.81	11.95								
8	13	30.6	2.05	6.70												
9	4	31.3	1.61	5.33												

Key n = Number of Tests
$\bar{x}$ = Average Strength
δ = Standard Deviation
V = Coefficient of Variation

28 DAY COMPRESSIVE STRENGTH TEST RESULTS

SUMMARY SHEET

Region: Eastern

Year: 1983

CONTRACT NO. E-	20 MPa				30 MPa				35 MPa				___ MPa			
	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V
1					23	30.9	5.06	16.38								
2	11	30.3	5.29	17.46	10	29.6	2.48	8.37								
3	1	20.8	-	-	12	28.6	4.80	16.78								
4	3	26.9	3.84	14.28												
5	4	33.3	3.84	11.53												
6	4	26.0	4.46	17.14	5	34.1	4.22	12.39								
7	6	31.3	5.00	15.99	10	33.1	1.85	5.58								
8a	3	26.4	1.65	6.25												
8b	5	25.4	3.12	12.28	18	32.9	5.31	16.14								
9	10	24.6	4.40	17.89	5	29.2	2.81	9.64								
10					36	32.2	2.94	9.16								
11					3	31.4	1.97	6.28								
12					7	32.5	3.34	10.27								
13a	5	34.5	6.52	18.95	4	34.9	0.29	0.83	3	42.0	2.57	6.12				
13b	2	28.9	1.62	5.61												

Key n = Number of Tests
$\bar{x}$ = Average Strength
δ = Standard Deviation
V = Coefficient of Variation

28 DAY COMPRESSIVE STRENGTH TEST RESULTS

SUMMARY SHEET

Region: Eastern

Year: 1983

CONTRACT NO. E-	20 MPa				30 MPa				35 MPa				25 MPa			
	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V	n	$\bar{x}$	δ	V
14	4	31.4	2.42	7.71									4	33.1	2.74	8.27
15	8	29.8	3.03	10.17	31	30.5	3.69	12.07								
16					18	36.7	4.96	13.50								
17a	17	33.4	3.55	10.64												
17b					10	35.1	3.70	10.53								
17c					24	35.0	2.67	7.62								
17d	1	37.9	-	-												
18	2	37.7	8.59	22.79	7	36.2	3.52	9.72								
19	3	33.7	1.43	4.24	6	33.3	3.47	10.43								
20	6	29.9	2.63	8.80												
21	4	30.2	3.06	10.11												
22	1	28.7	-	-	4	32.6	3.21	9.85								
23					2	28.4	-	-					2	25.2	-	-
24					3	31.4	1.97	6.28								